THE Geologic COLUMN OF MISSOURI

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Fred Weber, Inc.
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LIMESTONE

MISSOURI'S BILLION DOLLAR INDUSTRY

The production of limestone contributes about one billion dollars annually to Missouri's economy, but is often taken for granted. Many people drive past limestone quarries on a daily basis without noticing or thinking about the great value of this resource. The diverse uses of limestone in our modern world are more numerous than one may realize and limestone-derived products allow us to maintain a high standard of living.

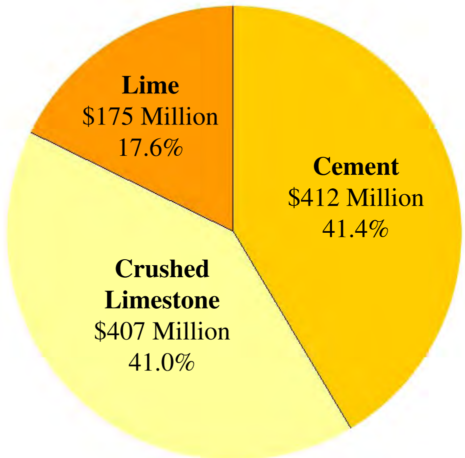
Products derived from limestone are abundant in the homes in which we live, in the roads and bridges on which we drive, in the buildings in which we work, in the foods that we eat and in the purification of the water that we drink. Limestone is also a critical component in the manufacture of aglime, pharmaceutical products, paint, glass, cement and pollution control technologies. Limestone and its derivative products play a crucial role in our daily lives.

MISSOURI DEPARTMENT OF NATURAL RESOURCES
Division of Geology and Land Survey

USES OF LIMESTONE

Limestone is an important commodity in Missouri. It has been utilized for construction purposes since the settlement of the state. Limestone has numerous uses that range from agricultural applications to building materials to medicines. A type of limestone that has somewhat different chemical and physical charateristics is called dolomite. Many limestone products require rock with specific physical and chemical characteristics. The specific chemical properties of a particular limestone or dolomite deposit will dictate applications for which that material may be used. Some limestones are sought for their use in producing lime, pharmaceuticals and in glass-making; whereas dolomites may be best suited for aggregate and construction uses.

LIMESTONE-BASED MINERAL COMMODITIES IN MISSOURI FOR 2004



Total Value: $994 Million

TYPES OF LIMESTONE

Sedimentary in origin, limestone is primarily composed of calcium carbonate, $CaCO_3$. Dolostone (commonly called dolomite) is calcium magnesium carbonate, $CaMg(CO_3)_2$. Although chemically and physically unique, limestone and dolomite are in many cases simply referred to as "limestone." There are many variations of these types of rock depending on the mineral content and the amount of silica, shale or other impurities that occur.

Deposited in warm, shallow seas, limestones are widely distributed across the earth. Limestone deposits often comprise the aquifers from which we get water, act as stratigraphic reservoirs for oil and gas deposits, and are widely used as industrial minerals. Some limestones are formed almost entirely of skeletons of marine organisms and form very distinctive fossiliferous rocks. Other limestones are the consolidated equivalent of lime mud and have a very small grain size and a smooth texture.

LIME

Lime plays a key role in many air pollution control technologies. It is used to remove sulfur dioxide and hydrogen chloride from various flue gas emissions. Lime is also routinely used to treat municipal wastewater, industrial sludges and animal wastes where it is used to neutralize pH, precipitate metals and control odors. It is also the primary treatment agent for many domestic and industrial water supplies where it is utilized as a filter, as an acid neutralizer and a chemical precipitant. Lime is also used in the paper and pulp industry, as a flux in steel manufacturing and is essential in the production of sugar. When mixed with water and a few other ingredients, lime becomes whitewash, a common paint of the 19th century.

Commonly known as "aglime," agricultural limestone is basically pulverized limestone used in the agricultural field to change the physical and chemical properties of the soil. Aglime is an important soil amendment that can be added to crop land to neutralize soil acidity, prevent erosion and increase crop yield. Dolomitic aglime adds both calcium and magnesium to the soil and improves water and nutrient uptake of the plant. Aglime may also improve the efficiency of fertilizers and herbicides.

AGGREGATE

One of the most important uses for limestone is construction aggregate. Limestone aggregate is one of the largest mining industries in the world. It is produced from crushed quarry rock. Production and processing involves mining rock from a suitable location then crushing, screening and washing it to obtain the proper cleanliness and gradation. The aggregate is then stockpiled and finally shipped to the site for use in a wide variety of construction applications. Highways, homes, businesses and countless infrastructure components could not be built without the use of large amounts of aggregate. The American Geological Institute estimates that 229 tons of aggregate are needed for a 2,000 square foot two-story house, with a full basement and that one mile of a typical two-lane asphalt highway, with a crushed stone base, requires 25,000 tons of aggregate.

CEMENT

Another important use of limestone is the production of portland cement. Cement is produced by burning finely crushed limestone with secondary raw materials such as shale, sand, and fly ash. The resulting product, called "clinker," is then mixed with gypsum and finely ground. The most common use of cement is in the production of concrete.

IMPACTS OF LIMESTONE MINING

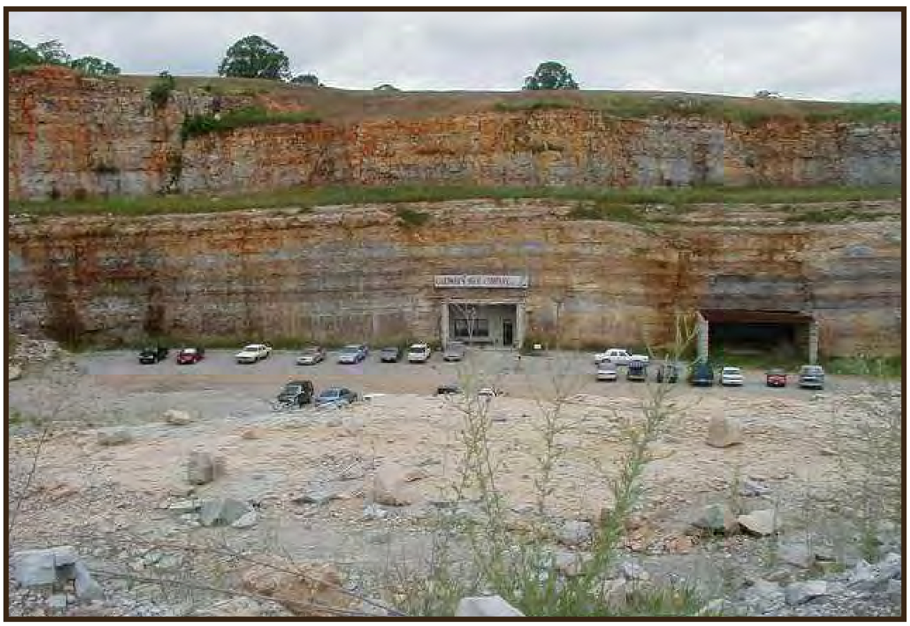
ENVIRONMENTAL

Limestone mining can have a dramatic effect on the landscape during the actual removal of the resource. However, properly managed quarry operations strive to isolate impacts from surrounding properties and may even improve the environment on a long term basis. Modern technology, environmental regulations, permitting requirements and sound and safe operational practices effectively minimize a mine's influence on air quality, water quality and the physical landscape.

Modern quarry operations develop comprehensive operation and closure plans. Quarries are required to control storm water discharge, control fugitive dust emissions and implement site stabilization and reclamation at the end of the quarry life.

In some cases, when mining is complete, the site may be converted into other uses. Several underground mines in the state have been converted into warehouses, office space, recreation facilities and storage units. These uses offer significant advantages such as naturally controlled temperature and humidity, low maintenance costs and added security.

Open pit mines have been converted into recreation facilities, home sites, wildlife refuges and wetlands. A few even become solid waste disposal areas.



ECONOMIC

Missouri's limestone industry is vital to the state's economy and essential to our way of life. Missouri ranks first in the nation in the production of lime, fourth in the production of crushed limestone and fifth in the production of portland cement. The Missouri Limestone Producers Association (MLPA) reports that limestone is mined in 92 of Missouri's 114 counties and the industry employs more than 2,500 people. In 2004, the production of limestone commodities was valued at nearly one billion dollars, accounting for over 60% of Missouri's produced mineral value. All this resulted from an estimated 75 million tons of mined limestone.

In Missouri, aggregate limestone production accounts for more than one-fourth of the state's non-fuel and non-metallic mineral production. The standard of living that we have come to expect largely depends on the economic availability of an abundant supply of limestone resources.

FUTURE

Society has created a demand for access to a readily available supply of high quality, economically recoverable limestone resources. It is important that these resources are developed while taking into consideration land use planning, local ordinances and public input without causing unacceptable environmental impacts. With continued development of transportation and infrastructure, construction demands and environmental improvement, it is anticipated that the demand for limestone derived products will continue to increase.

FOR MORE INFORMATION

For additional information you may contact the Geological Survey Program, at **(573) 368-2100.**
The following Web sites offer additional information about limestone, mineral resources and geology:

Geological Survey Program	www.dnr.mo.gov/geology
United States Geological Survey	www.usgs.gov
American Geological Institute	www.agiweb.org
Missouri Limestone Producers Association	www.molimestone.com

A MOMENT IN TIME

Limestone has been a valuable resource in Missouri since the settlement of the state. This photo of the Lohrum Quarry in St. Louis was taken about 1900. It shows open pit quarry operations at a time when many activities were performed by hand. Mules, tramways, and ore carts were used to move limestone out of the quarry. Workers can be seen processing, moving and hand loading quarry rock into ore carts. The machinery in the lower left corner of the photo is an early steam-powered rock drill. This was used to drill holes along the quarry face in order to set explosive charges.

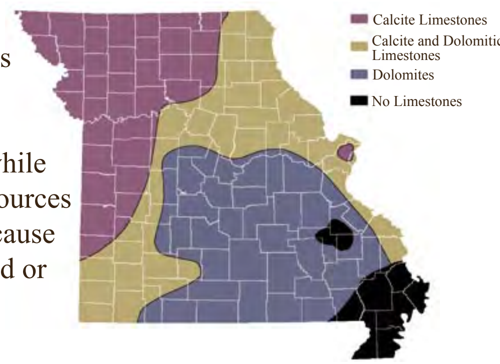
MINING

Limestone is mined using both surface and underground methods. Underground methods involve removal of limestone "rooms" while leaving regularly spaced "pillars" in place to support the overlying roof. These operations can be extensive and often encompass several hundred acres. Underground mining is commonly used when a specific rock layer is desired or in areas where there is thick material overlying the desired rock.

Surface quarrying is a considerably more common method of producing limestone in Missouri and is typically much more economical than underground mining methods. Many surface operations are simply hillside cuts or open pit type quarries. Controlled blasting at the quarry face is used to break the rocks into pieces. If necessary, this material is further reduced in size by rock crushers to a desirable size. The rock is then separated and cleaned. This type of operation is common in Missouri.

OCCURRENCES

Limestone bedrock occurs in most parts of the state. In some cases, limestone crops out at the surface while in other regions these resources are difficult to extract because they are deep underground or are too thin to be mined economically.



In the northern and western parts of the state, Pennsylvanian age limestone occurs in deposits up to about twenty feet thick, interbedded with shale, clay, sand and coal. Many of these deposits are simply too thin to be of economic value. In other cases, they are deeply buried under glacial sediments and extraction is not practical. An exception to this is the Kansas City area, which does have several mineable units close to the surface. However, in some northern Missouri counties, there is no limestone production at all.

The southwest and parts of the central and eastern region of the state contain important limestone. These deposits consist of relatively thick, high calcium limestone of the Mississippian, Devonian and Middle Ordovician age. Much of this limestone is used to produce construction aggregate, cement and lime. The deposits in the eastern region are strategically located near major transportation corridors of the Missouri and Mississippi Rivers.

The central and south-central parts of the state contain extensive deposits of dolomite and dolomitic limestone. These rock units are primarily Lower Ordovician and Cambrian age units and are mined primarily for use as construction aggregate and in agricultural applications.

THE NIXA SINKHOLE

The dramatic impact of a sinkhole collapse in a residential area in Christian County was realized Sunday morning August 13, 2006. Missouri Department of Natural Resources, Division of Geology and Land Survey geologists Peter Price, Glen Young and Jerry Prewett coordinated efforts to assess the risk to other nearby residents and to provide assistance to stabilize the situation.

The sinkhole collapse was at the home of Norman Scrivener in Nixa. Centered roughly beneath the attached garage, the collapse initially measured approximately 44 feet in diameter and 40 feet deep. The garage and vehicle parked inside, fell into the sinkhole where sloughing soil material from the sides of the sinkhole had partially filled the sink bottom. The depth of the sinkhole reportedly measured about 75 feet when the sinkhole throat was visible.

Knowing further collapse could jeopardize adjacent homes and city utilities, DGLS geologists met with city officials, consultants, utility companies and staff from Missouri State University to discuss observations and to recommend remedial actions. An organized effort ensued to stabilize the sinkhole, to keep the remainder of the house from being swallowed and to reduce the risk of injury in the area.

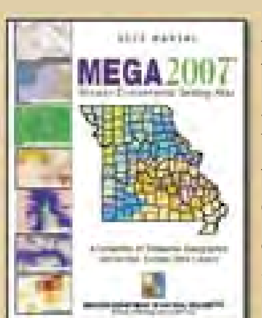
Bedrock beneath the City of Nixa is the Mississippian-age Burlington Limestone, a coarse grained fossiliferous limestone containing both chert nodules and beds. Burlington Limestone typically weathers severely along fracture traces to create a very irregular bedrock surface. It is also responsible for the development of solution channels and conduits within the bedrock (caves) that rapidly transport groundwater to area springs. Sinkholes form in this geologic setting (known as a karst plain or plateau) as a result of the residuum washing and/or collapsing into solution conduits.

DGLS regularly assists citizens seeking advice concerning collapses occurring on their property. The division utilizes a statewide GIS sinkhole coverage and database developed at DGLS to inform citizens about the locations of known sinkholes and potential for karst collapse in relation to their homes. Few sinkhole collapses in Missouri result in damage to buildings. More frequently, sinkhole collapses adversely impact a lake or pond. Although infrequent, this type of event, illustrates the dramatic impact that natural geologic hazards can have on the lives of people.

Limestone aggregate used to stabilize the collapse was donated by Leo Journagan Const. Co., Springfield, MO.

MEGA 2007

The MEGA 2007 CD-ROM is a collection of interactive computer maps that allow the user access to more than 30 statewide Geographic Information System (GIS) data layers, all from their computer desktop. Significant improvements and additions have been made since MEGA's debut in 2003. New data layers have been added and many of the existing data layers updated.



Among the additions is a water table map showing uppermost groundwater elevations, giving users an idea of what direction the groundwater is moving. Other new data layers include drill areas depicting requirements for well construction and a mine and mineral occurrence layer.

A significant addition to the existing well log layer includes a simplified well log that lists various materials encountered during drilling. House and Senate district boundaries are also part of the collection. Additional data layers include: bedrock geology, well and spring locations, dyetrace data, State Park and Historic Site boundaries, geologic structures, sinkhole locations, alluvial floodplains, certified wells, public water supply wells, dye traces, surficial materials, stream hydrology and the public land survey system. This CD-ROM also provides public domain information such as streams, lakes, major roads, urban areas and county boundaries.

Users will find a multitude of applications for the new data layers and improvements included with this new edition (MEGA 2007). Getting more information in the hands of decision-makers across the state will help everyone do their job better.

NEW PUBLICATIONS

NEW GEOLOGIC MAPS

OFM-06-512-GS **Bedrock Geologic Map of the Hawk Point 7.5' Quadrangle, Lincoln and Warren Counties, Missouri** by Mark A. Middendorf, 2006, scale 1:24,000.

OFM-06-513-GS **Bedrock Geologic Map of the Warrenton Northeast 7.5' Quadrangle, Lincoln and Warren Counties, Missouri** by Mark A. Middendorf, 2006, scale 1:24,000.

OFM-06-514-GS **Bedrock Geologic Map of the Americus 7.5' Quadrangle, Montgomery County, Missouri** by Edith A. Starbuck, 2006, scale 1:24,000.

OFM-06-515-GS **Surficial Material Geologic Map of the Americus 7.5' Quadrangle, Montgomery County, Missouri** by Mike Chalfant, Wyn Kelley and Mike Siemens, 2006, scale 1:24,000.

OFM-06-516-GS **Bedrock Geologic Map of the Montgomery City 7.5' Quadrangle, Montgomery County, Missouri** by Christopher B. Vierrether, 2005, scale 1:24,000.

OFM-06-517-GS **Surficial Material Geologic Map of the Montgomery City 7.5' Quadrangle, Montgomery County, Missouri** by Mike Chalfant, Wyn Kelley and Mike Siemens, 2006, scale 1:24,000.

OFM-06-518-GS **Surficial Material Geologic Map of the Wentzville 7.5' Quadrangle, St. Charles County, Missouri** by James R. Palmer, 2006, scale 1:24,000.

These and other publications may be purchased through the Missouri Department of Natural Resources, Division of Geology and Land Survey.

To order a copy, contact the publications desk at: (573) 368-2125 or 1-800-361-4827, or use our online form at: www.dnr.mo.gov/geology/adm/publications/MapsOrder.htm.

For additional information visit our web site at: www.dnr.mo.gov/geology, or call us at: (573) 368-2100.

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